National Research Council Canada
Conseil national de recherches Canada

Division of Electrical Engineering
Division de génie électrique

ERB-97

15 cm Transverse Electromagnetic (TEM) Cell

B.C. Farr and J.G. Dunn

August 1985

Canada

NRCC No. 24879

86-02691/

Copyright 1985 by
National Research Council of Canada

Permission is granted to quote short excerpts and to reproduce figures and tables from this report, provided that the source of such material is fully acknowledged.

Copyright 1985 par
Conseil national de recherches du Canada

Il est permis de citer de courts extraits et de reproduire des figures ou tableaux du présent rapport, à condition d'en identifier clairement la source.

Additional copies are available free of charge from:

Editorial Office, Room 301
Division of Electrical Engineering
National Research Council of Canada
Ottawa, Ontario, Canada
K1A 0R8

Des exemplaires supplémentaires gratuits peuvent être obtenus à l'adresse suivante:

Bureau des publications, Pièce 301
Division de génie électrique
Conseil national de recherches du Canada
Ottawa (Ontario) Canada
K1A 0R8

15 cm TRANSVERSE ELECTROMAGNETIC (TEM) CELL

B.C. Farr and J.G. Dunn

ERB-979
NRCC No. 24879

AUGUST 1985

TABLE OF CONTENTS

	Page
ABSTRACT/RÉSUMÉ	v
DESIGN ELEMENTS	1
DEVELOPMENT ELEMENTS	2
LIST OF MATERIALS, DRAWINGS AND PARTS REQUIRED IN DEVELOPING THE TEM CELL	2
Materials and Drawings	2
Parts	3
Steps and Procedures in Development of TEM Cell	3
SET-UP AND CALIBRATION	8
CONCLUSIONS	10
DESIGN DRAWINGS	11
EF-4-4D	12
EF-4-5A	16
EF-4-6A	18
EF-4-7A	20
EF-4-8A	21
EF-4-9A	22
EF-4-10A	23
EF-4-11A	24
EF-4-12A	25
EF-4-13A	26
EF-4-14A	27
EF-4-15A	28
EF-4-16A	29

ABSTRACT

A method of establishing a uniform E field was required to calibrate E field sensors in the frequency domain to 1 GHz.

A commercial transverse electromagnetic cell (TEM) was borrowed, but was found to be inadequate. E field uniformity of ±0.10 dB was required in the frequency domain to 1 GHz. A new TEM cell with improved set-up and use features was designed and developed. The majority of impedance adjustment is done in the square coaxial adaptor at both ends of the TEM cell.

RÉSUMÉ

Méthode d'établissement d'un champ électrique uniforme pour l'étalonnage de détecteurs du champ électrique dans la plage de fréquences s'étendant jusqu'à 1 GHz.

Les chercheurs ont emprunté une cellule électromagnétique transversale (TEM) disponible sur le marché mais ont constaté qu'elle ne convenait pas au projet. La recherche visait à produire un champ électrique uniforme à 0.10 dB près dans la plage de fréquences s'étendant jusqu'à 1 GHz. On a conçu et développé une nouvelle cellule comportant de meilleures caractéristiques de montage et d'exploitation. Le réglage de l'impédance s'effectue surtout dans l'adaptateur coaxial carré à chaque extrémité de la cellule TEM.

15 cm TRANSVERSE ELECTROMAGNETIC (TEM) CELL

B. Farr and J. Dunn

DESIGN ELEMENTS

1. The outward-fabricated lip on the top edge of the main body allows:

   - easier access for adjustments and accessibility to the inner cavity
   - stronger body construction
   - better shielding and electrical continuity, with close-spaced screws fastening the cover to the TEM cell main body
   - obstruction-free inner cavity

2. The square coaxial adaptor, fixed with screws onto the main body, reduces electrical distortion by adding adjustments in the transition region of the Type N coaxial adaptor to the tapered region of the TEM cell. This enables the cell to be precisely set up, having low return loss and low insertion loss.

3. The square brass centre conductor, mounted in the square coaxial adaptor, provides positive and secure mounting from the Type N panel connector pin to the septum.

4. A stainless steel plate, with threaded holes, is used to replace nuts for mounting the Type N connector to the square coaxial adaptor.

5. Stainless steel nut presserts were embedded in the ends of the body of the TEM cell, allowing screws to connect the square coaxial adaptor to the body. The presserts provide positive and secure mounting of the square coaxial adaptor to the main body of the cell.

6. The removable top lid of the cell can be duplicated and modified to permit access to the chamber with minimum interference to the E field within the cell.

Features 4 and 5 provide obstruction-free mounting of the Type N coaxial connector and square coaxial adaptor, eliminating any electrical discontinuity due to the obstruction of screws within the inner cavity. These two components can also be easily dismantled for replacement, because stainless steel provides an excellent reusable thread.

DEVELOPMENT ELEMENTS

A one-piece development layout of the aluminum main body provides negligible distortion from welding and accurate, equidistant measurements throughout the fabrication of the body.

Steel fixtures and copper heat sinks are used throughout construction of the TEM cell, and consist of

1. copper heat sinks, clamped to the inside joints through the open ends of the cell body during welding, which prevent penetration of the welds and distortion to the body due to localized heat

2. a steel top plate which holds the main cell body dimensionally stable during welding

3. a section (½" × 1") of precision waveguide, which spans the length of the TEM cell, and provides for accurate mounting of the square coaxial adaptor to the cell body and the Type N coaxial connector pins to the septum in the TEM cell

LIST OF MATERIALS, DRAWINGS AND PARTS REQUIRED IN DEVELOPING THE TEM CELL

Materials and Drawings

1. body layout — 21-1/8" × 21" × 0.064" × 3003H14 aluminum. Drawing No. EF-4-5A

2. coaxial adapter box — 2 required, 3-13/16" × 2-11/16" × 0.064 × 3003H14 aluminum. Drawing No. EF-4-6A

3. top cover — 21-27/32" × 10" × 0.125 × 6061T6 aluminum. Drawing No. EF-4-7A

4. septum — 17-3/4" × 6-41/64" × 0.050 × hard brass. Drawing No. EF-4-8A

5. brass connector bars — 2 required, 3/8" × 3/8" × 1-1/2" brass. Drawing No. EF-4-9A

6. septum spacers — 4 required, 1-23/64" × 1/2" Teflon rod. Drawing No. EF-4-10A

7. septum supports — 2 required, 2-15/16" × 1/2" Teflon rod. Drawing No. EF-4-11A

8. coaxial connector mounting plate — 2 required, 1-1/16" × 61/64" × 1/16" stainless steel. Drawing No. EF-4-12A

9. development fixture (A) — 4 required, 1/16" × 2" × 7/8" copper. Drawing No. EF-4-13A

10. development fixture (B) and (C) — 4 required, 6-11/32" × 1" × 0.125" hard copper. Drawing No. EF-4-14A and 15A

11. development fixture (D) — 17-29/32" × 9-1/2" × 0.075 mild steel. Drawing No. EF-4-16A

Parts

1. coax panel connectors, type N — 2 required, (UG-58A/U). Part No. 501

2. screws, binding head — 54 required, # 4-40 × 1/4". Part No. 502

3. screws, pan head, nickel plated — 12 required, # 4-40 × 1/8". Part No. 503

4. nuts, pressert, stainless steel — 12 required, # 4-40 × 0.060. Part No. 504

5. screws, pan head, nickel plated — 8 required, # 4-40 × 1/4". Part No. 505

6. screws, flat head, brass — 2 required, # 4-40 × 3/8". Part No. 506

7. screws, flat head, nylon — 6 required, # 4-40 × 1/2". Part No. 507

8. screws, fillister head, stainless steel — 6 required, # 6-32 × 1/2". Part No. 508; c/w small nuts. Part No. 509

9. development fixture — 2 required, 1/8" × 1-1/16" × 1-1/16" copper. (See Fig. 3)

10. development fixture — 19-3/4" × 1" × 1/2" copper waveguide. (See Fig. 4)

11. conductive coating — Emmerson & Cuming product code # CC-40.

Steps and Procedures in Development of TEM Cell

All bends are to be done in "PRESS BRAKE" using dies to maintain a minimum radius. All bend lines to be centred in dies (see Fig. 1).

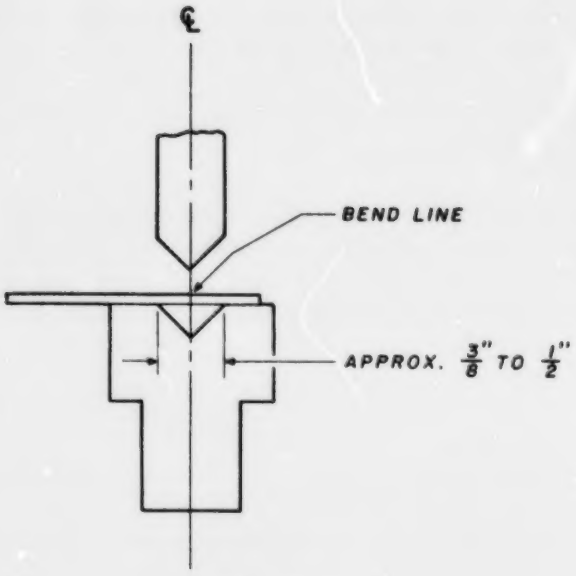


Figure 1

1. Cut out, punch holes, and form body.

2. Cut out development fixture D, punch holes, and form.

3. Clamp development fixtures B and C against inside joints of body (use 1" C clamps) (see Fig. 2).

4. Clamp development fixture D to body using 5" vise grip pliers in eight locations while also clamping development fixture A under lip of body at open joints to prevent penetration from welding (see Fig. 2).

5. Weld joints of body; remove development fixtures.

6. Cut out, punch holes, and form coaxial adaptor boxes.

7. Clamp copper heat sinks 1/8" × 1-1/16" × 1-1/16" inside of adaptor boxes; weld joints (See Fig. 3).

8. File and sand using emery cloth outside welded joints of body and adaptor boxes (see Assembly Drawing No. EF-4-4D, sheet 2 of 4).

9. Clamp adaptor boxes in position on body using 19-3/4" × 1" × 1/2" waveguide and two 1" C clamps or accurate facsimile (see Fig. 4).

10. Spot drill 12 holes through lips of adaptor boxes onto TEM cell body (see Fig. 4).

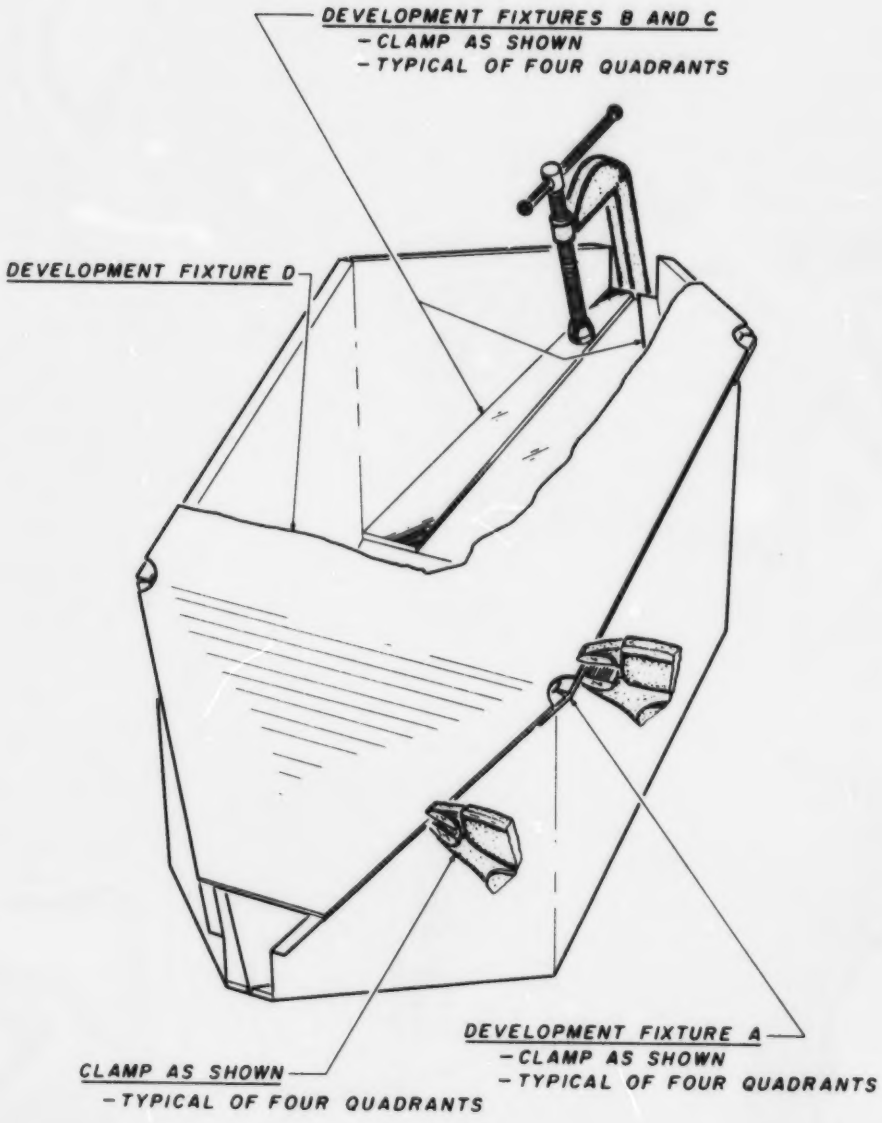

DEVELOPMENT FIXTURES B AND C
- CLAMP AS SHOWN
- TYPICAL OF FOUR QUADRANTS
DEVELOPMENT FIXTURE D
DEVELOPMENT FIXTURE A
- CLAMP AS SHOWN
- TYPICAL OF FOUR QUADRANTS
CLAMP AS SHOWN
- TYPICAL OF FOUR QUADRANTS

Figure 2

11. Remove adaptor boxes; accurately drill spotted holes in body using #8 drill.

12. Install #4-40 stainless steel pressert nuts in drilled holes of body by carefully hammering flush to inside surface of body.

13. Attach adaptor boxes on body with screws (Part No. 503) — blend and smooth inside corners where boxes are attached to body.

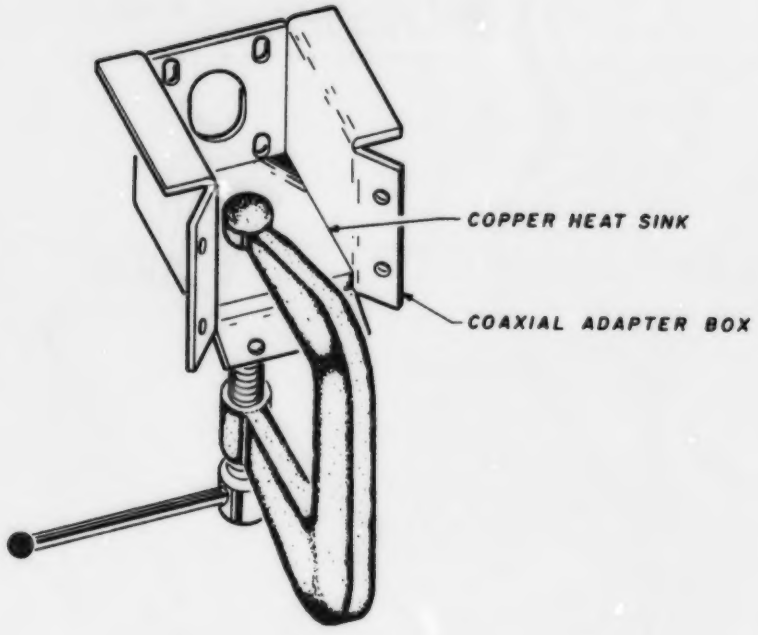


Figure 3

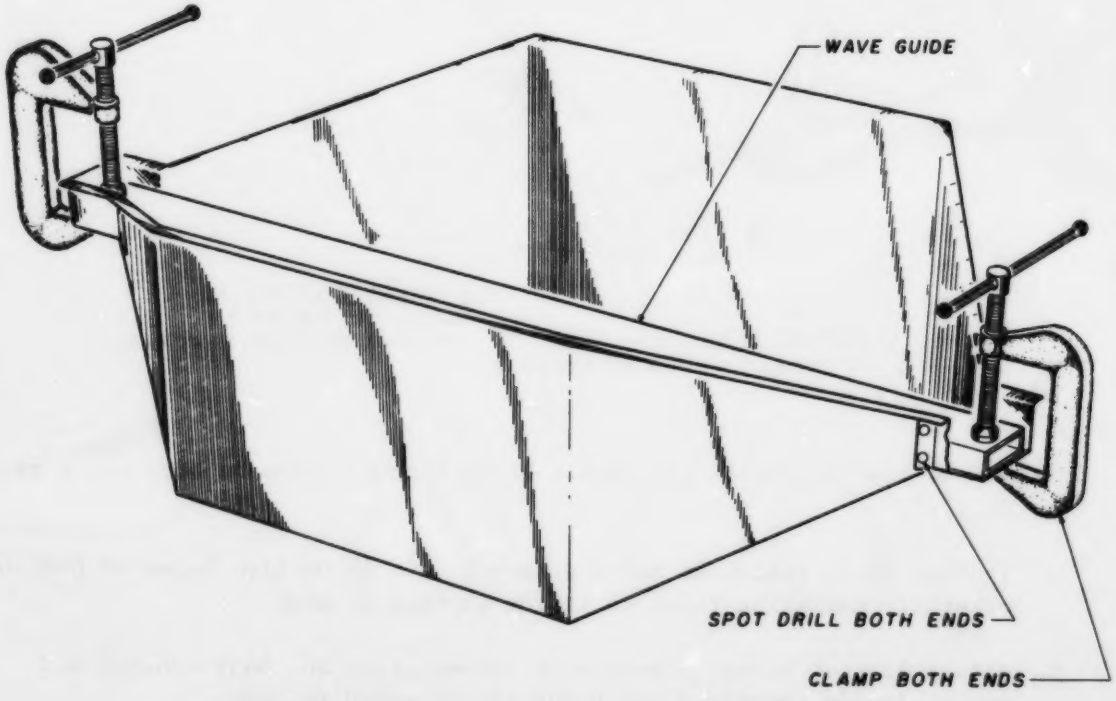


Figure 4

14. Remove adaptor boxes from body; clean and coat surfaces with conductive coating where boxes make contact with body; reattach to body with screws and tighten.

15. Mount Teflon supports in base of body with screws (Part No. 507).

16. Attach coaxial panel connectors with screws (Part No. 505) and coaxial connector mounting plates to adaptor boxes; finger tighten screws.

17. Accurately on surface table, scribe lines with height gauge on outside surface of TEM cell body where Teflon spacers are to be mounted (see Fig. 5).

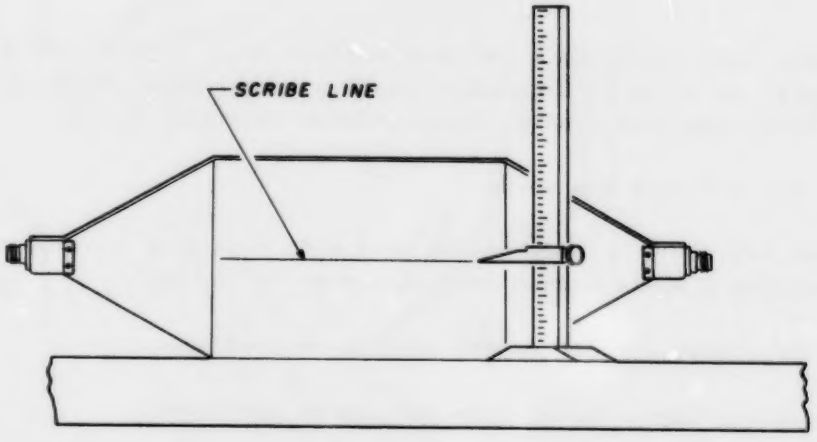


Figure 5

18. Accurately drill and countersink four holes for #4 screw.

19. Position Teflon spacers on septum.

20. Mount septum inside TEM cell with screws (Part No. 507).

21. Attach brass connector bars to panel connectors (Part No. 501) and septum.

22. Accurately align panel connectors on surface table with height gauge by moving connectors up or down until centred with septum. Tighten screws holding panel connectors to adaptor boxes.

23. Scribe reference line on adapter boxes for alignment of panel connectors at assembly.

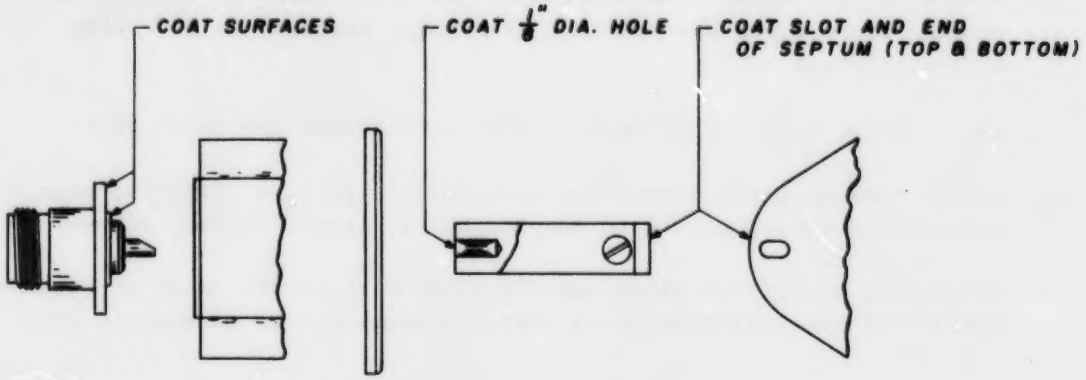


Figure 6

24. Remove panel connectors and coat surface which makes contact with adaptor boxes using conductive coating; reassemble panel connectors on adaptor boxes and evenly tighten screws (see Fig. 6).

25. Cut out and form top cover.

26. Clamp top cover on body of TEM cell with vise grip pliers; scribe a line on top where excess amounts are to be cut off.

27. Remove cover; cut off excess amounts on band saw.

28. Accurately layout mount hole pattern on top cover.

29. Punch 1/8" holes in cover where possible; accurately drill remaining holes.

30. Clamp top cover on body of TEM cell; spot drill through cover onto lip surface of TEM cell.

31. Remove cover; drill and tap spotted holes #4-40 on lip surface of body.

32. Install six tuning screws (Part No. 508) and nuts (Part No. 509) in adaptor boxes.

SET-UP AND CALIBRATION

A Tektronix 7512 Time Domain Reflectometer (TDR) was used to adjust the brass centre conductor in the square coaxial adaptor section. The brass conductor is adjusted either towards or away from the end of the adaptor

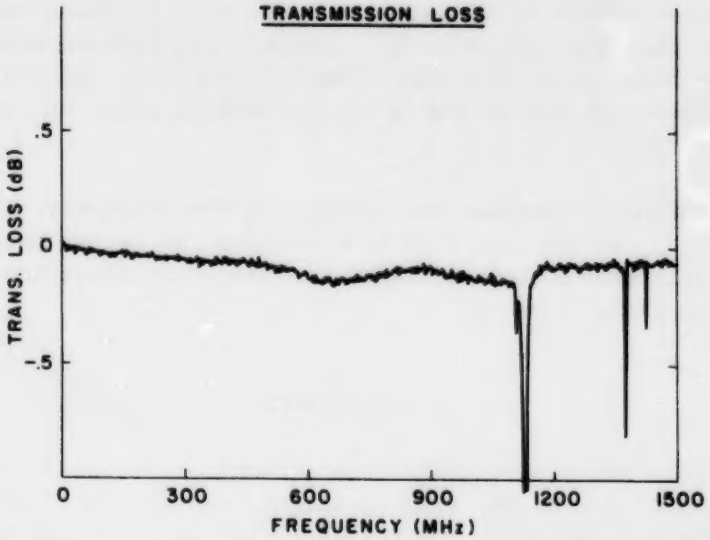


Figure 7

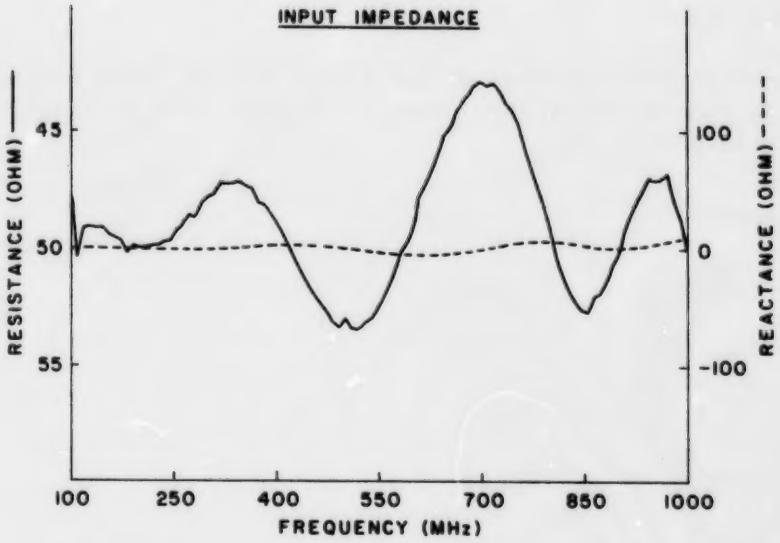


Figure 8

section, which provides the smoothest impedance transition to the septum. The end being adjusted is connected to the TDR output to lessen the effects of impedance mismatch distortion and simplify the set-up.

The next step is to tune out the input return loss using the three impedance-matching screws. An upper frequency limit of 1 GHz was used because this is the upper frequency limit of the cell. Carefully and accurately note position of brass connector bars in TEM cell. Remove bars

and coat surfaces where indicated with conductive coating, then reassemble in same exact position (see Fig. 6). Install and tighten screws (Part No. 506) into brass connector bars. Apply conductive coating to lips of TEM cell and assemble top to TEM cell with screws (Part No. 502) and tighten.

After ensuring all screws are secure and the conductive coating is in place and cured, measure the insertion loss of the cell. Using the above system, the cell should have an input impedance and insertion loss as illustrated in Figs. 7 and 8.

CONCLUSIONS

The TEM cell was used to calibrate a number of devices, some with coupling factors of >-80 dB, with excellent results. At such low coupling factors, leakage is of prime importance. The leakage level was determined by the cables connecting the TEM cell to the measuring equipment, not the cell itself. The removable top cover aided in mounting the device under test to the cell.

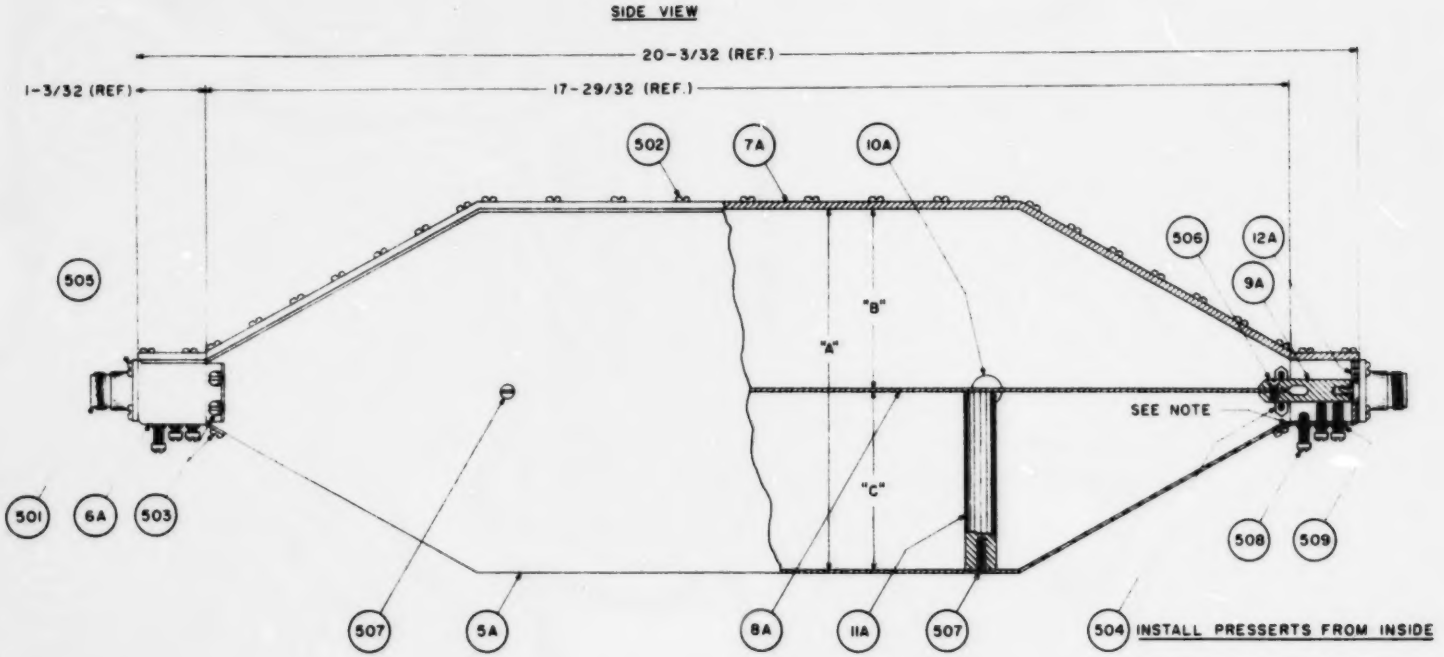
A one-third scale version of the above cell was also fabricated, scaling all dimensions by 1/3. Similar results were obtained to an upper frequency limit of 3 GHz.

DESIGN DRAWINGS

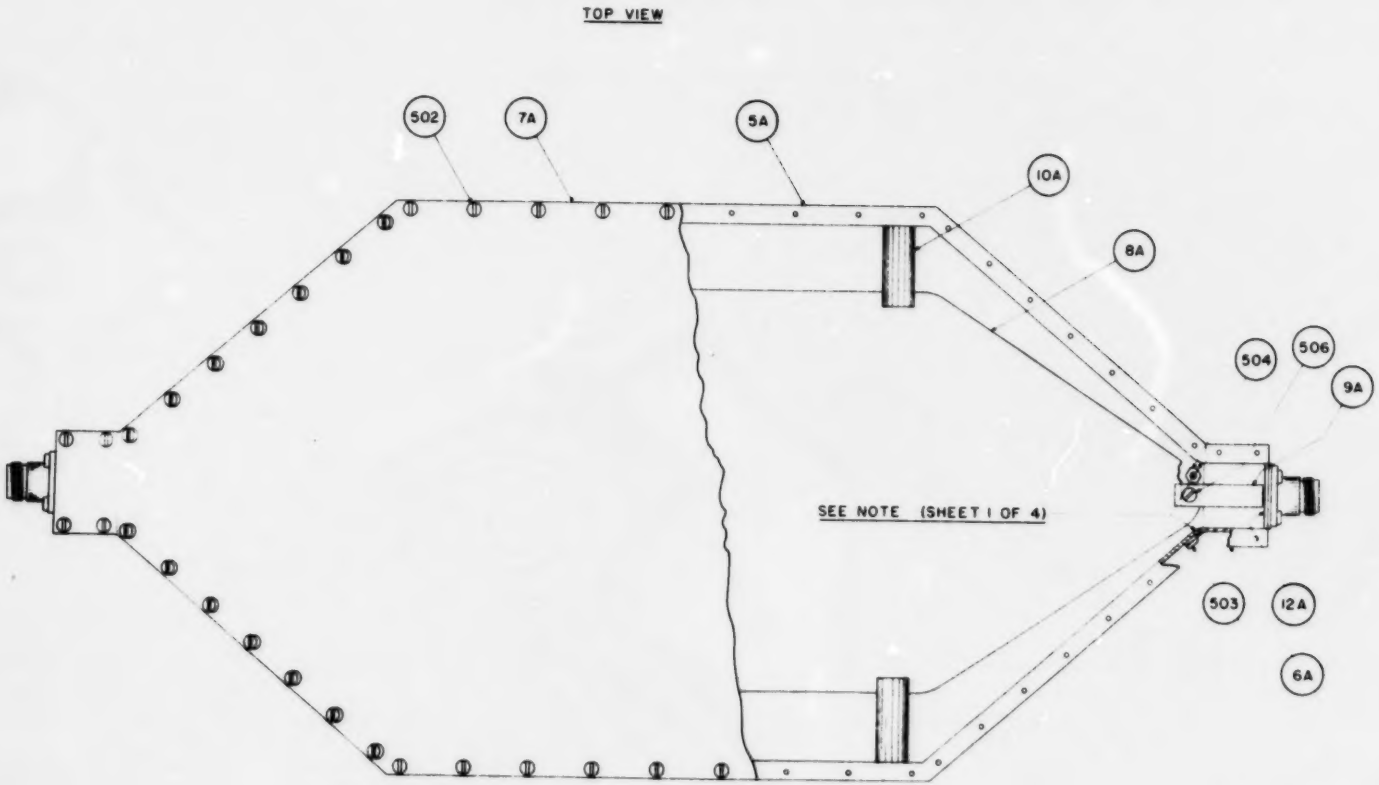
PROCEDURE FOR POSITIONING SEPTUM

STEP 1 – MEASURE INSIDE DEPTH OF BODY (DIMENSION "A")
STEP 2 – ONE HALF OF DIMENSION "A" IS THE VERTICAL POSITION OF MOUNTING HOLES (SEE NOTE 3 – DWG. NO. EF-4-5A) FOR LOCATION OF SPACERS (DWG. NO. EF-4-10A).
STEP 3 – CENTRE OF SEPTUM TO BE LOCATED AS IN STEP 2. "B" AND "C" TO BE EQUAL DISTANCE.
STEP 4 – SEPTUM SUPPORT (DWG. NO. EF-4-11A) TO BE EQUAL IN LENGTH TO DIMENSION "C".

NOTE: FILE EDGE OF BODY (DWG. NO. EF-4-5A) ON THREE SIDES TO BLEND WITH COAXIAL ADAPTER BOX (DWG. NO. EF-4-6A).

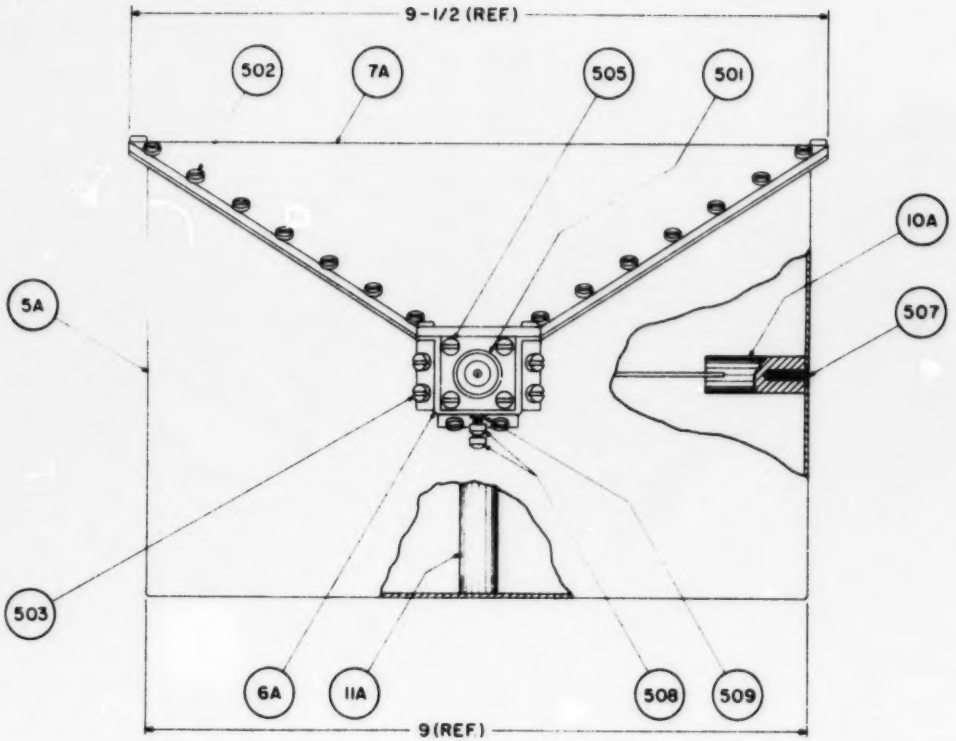


Title: 15 cm TEM cell. Project: Extra fast impulse. Drawing No.: EF-4-4D. Sheet 1 of 4.



Title: 15 cm TEM cell. Project: Extra fast impulse.
Drawing No.: EF-4-4D. Sheet 2 of 4.

SIDE VIEW



Title: 15 cm TEM cell. Project: Extra fast impulse.
Drawing No.: EF-4-4D. Sheet 3 of 4.

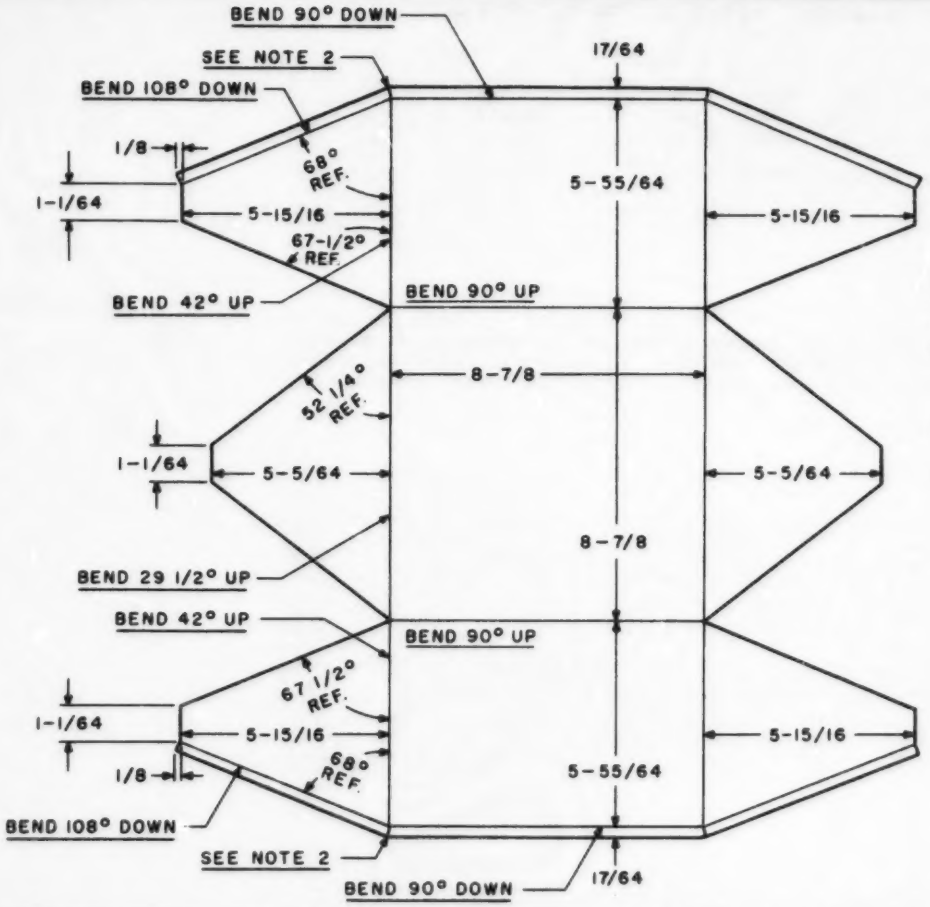
DWG. NO.	QT'Y	MAT'L	DESCRIPTION
EF-4-5A	1	ALUMINUM	BODY (2 SHEETS)
-6A	2	ALUMINUM	COAXIAL ADAPTER BOX (2 SHEETS)
-7A	1	ALUMINUM	TOP COVER
-8A	1	BRASS	SEPTUM
-9A	2	BRASS	CONNECTOR BAR
-10A	4	TEFLON	SPACER
-11A	2	TEFLON	SEPTUM SUPPORTS
-12A	2	STAINLESS STEEL	COAXIAL PANEL CONNECTOR MOUNTING PLATE

PART NO.	QT'Y	MAT'L	DESCRIPTION
501	2	STEEL	COAXIAL PANEL CONNECTOR (PART NO. UG-58 A/U
502	54	STEEL	SCREW, BINDING HEAD, 4-40 THREAD, 1/4 LONG
503	12	STEEL	SCREW, PAN HEAD, NICKEL PLATED, 4-40 THREAD, 1/8 LONG
504	12	STAINLESS STEEL	NUT, PRESSERT, FOR 1/16 PANEL, 4-40 THREAD
505	8	STEEL	SCREW, PAN HEAD, NICKEL PLATED, 4-40 THREAD, 1/4 LONG
506	2	BRASS	SCREW, FLAT HEAD, 4-40 THREAD, 3/8 LONG
507	6	NYLON	SCREW, FLAT HEAD, 4-40 THREAD, 1/2 LONG
508	6	STAINLESS	SCREW, FILLISTER HEAD, 6-32 THREAD, 1/2 LONG
509	6	STEEL	NUT, 6/32 (LOW PROFILE)

THE DRAWINGS LISTED BELOW ARE FIXTURE DRAWINGS AND ARE NOT SHOWN OR REFERRED TO ON THE ASSEMBLY DRAWINGS. THEIR PURPOSE IS DESCRIBED IN THE ACCOMPANYING STEPS AND PROCEDURES re DEVELOPMENT OF TEM CELL.

DWG. NO.	QT'Y	MAT'L	TYPE	DESCRIPTION
EF-4-13A	2	COPPER	A	DEVELOPMENT FIXTURE-A
	2		B	
-14A	2	COPPER	—	DEVELOPMENT FIXTURE-B
-15A	2	COPPER	—	DEVELOPMENT FIXTURE-C
-16A	1	STEEL	—	DEVELOPMENT FIXTURE-D

Title: 15 cm TEM cell. Project: Extra fast impulse.
Drawing No.: EF-4-4D. Sheet 4 of 4.



Dwg. No.–Dessin N°
EF-4-5A

NOTES:

1- REMOVE ALL BURRS & SHARP EDGES.
2- 4 NOTCHES ON OUTSIDE LIPS ARE TO BE CUT CLEAN WITH SNIPS SO AS NOT TO REMOVE ANY METAL FROM NOTCHES.
3- BODY LAYOUT TO BE CUT OUT ON BANDSAW TO PREVENT DISTORTION
4- BOTH SIDES SYMMETRICAL.

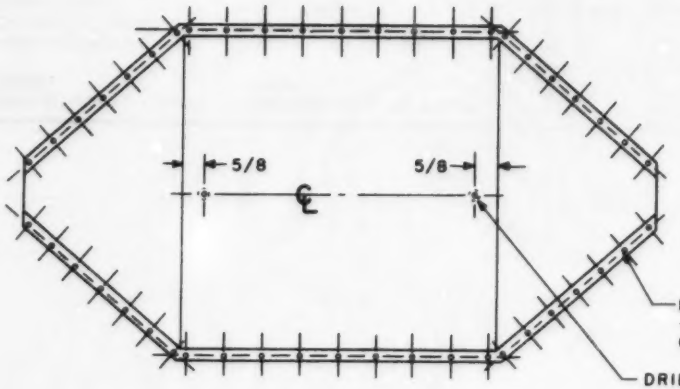
National Research Council Canada
Radio and Electrical Engineering Division
Ottawa, Canada
K1A 0R8

Conseil national de recherches Canada
Division de radiotechnique et de génie électrique
Ottawa, Canada
K1A 0R8

DRAWN BY / DESSINÉ PAR: P. AMIRAULT	MATERIAL–MATÉRIAUX: 3003H14 ALUM .064 THICK	TITLE–TITRE: BODY (LAYOUT)	
CHECKED BY / VERIFIÉ PAR: D. HOEY	QUANTITY–QUANTITÉ: 1	PROJECT–PROJET: EXTRA FAST IMPULSE	DATE: DEC./84
APPROVED BY / APPROUVÉ PAR:	ASS'Y–ASSEMBLAGE: EF-4-4D		Dwg. No.–Dessin N°: EF-4-5A

SHEET / FEUILLE 1 OF / DE 2

Dwg. No.–Dessin N°
EF-4-5A

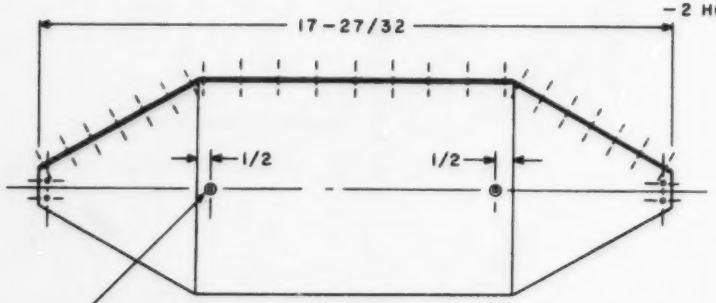


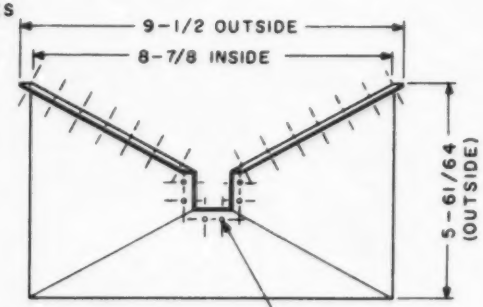
NOTES:

1–ALL JOINTS WELDED
2–HOLES DELETED IN SOME VIEWS FOR CLARITY
3–SEE PROCEDURE FOR POSITIONING SEPTUM (DWG. No. EF-4-4D, STEP 2)

DRILL No. 43 (.089 DIA.) AND TAP 4-40 THRU
-46 HOLES TO BE LOCATED ON ASS'Y BY SPOT DRILLING OFF OF TOP COVER (DWG. No. EF-4-7A)

DRILL No. 33 (.113 DIA.) AND C'SINK .225 DIA x 82° FROM UNDERSIDE
-2 HOLES



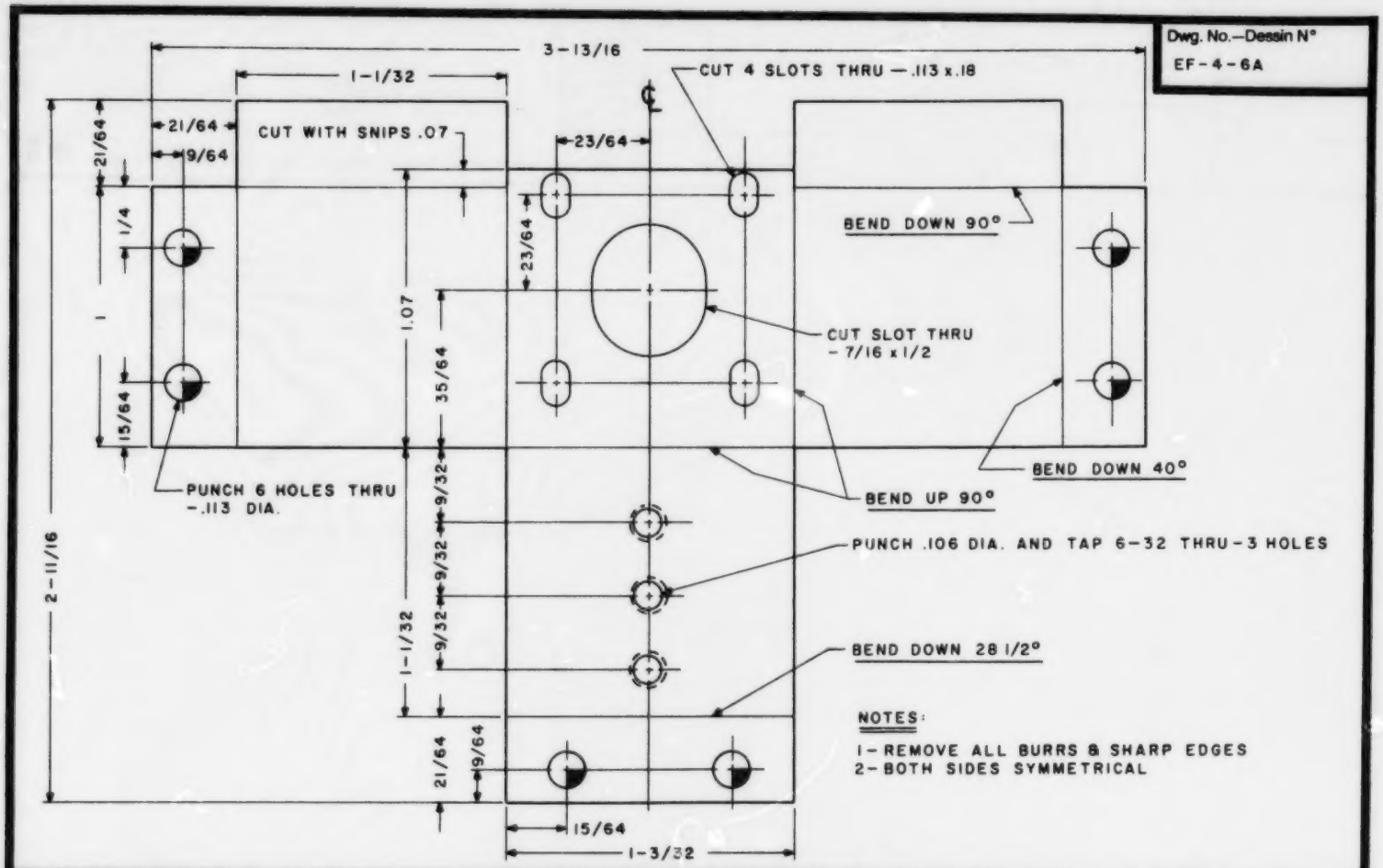


DRILL No. 33 (.113 DIA.) AND C'SINK .225 DIA x 82° FROM OUTSIDE
-4 HOLES (2 HOLES PER SIDE)
SEE NOTE 3

DRILL No. 8 (.199 DIA.) THRU
-6 HOLES TO BE LOCATED ON ASS'Y BY SPOT DRILLING OFF OF COAXIAL ADAPTER BOX (DWG. No. EF-4-6A)

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR: P. AMIRAULT CHECKED BY / VÉRIFIÉ PAR: D. HOEY APPROVED BY / APPROUVÉ PAR:	MATERIAL–MATÉRIAUX: — QUANTITY–QUANTITÉ: 1 ASS'Y–ASSEMBLAGE: EF-4-4A
		TITLE–TITRE: BODY (DEVELOPED) PROJECT–PROJET: EXTRA FAST IMPULSE	DATE: DEC./84 Dwg. No.–Dessin N°: EF-4-5A

SHEET / FEUILLE 2 OF / DE 2

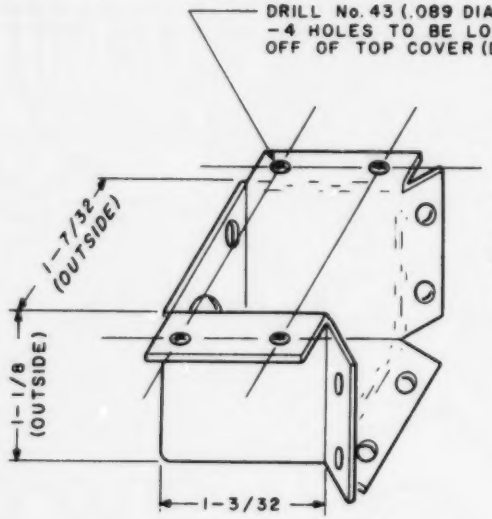


Dwg. No.—Dessin N°
EF-4-6A

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8 Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX 6061T6 ALUM. .064 THICK	TITLE—TITRE COAXIAL ADAPTER BOX (LAYOUT)	
	CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY—QUANTITÉ 2	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC./84
	APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D		Dwg. No.—Dessin N° EF-4-6A

SHEET / FEUILLE 1 OF / DE 2

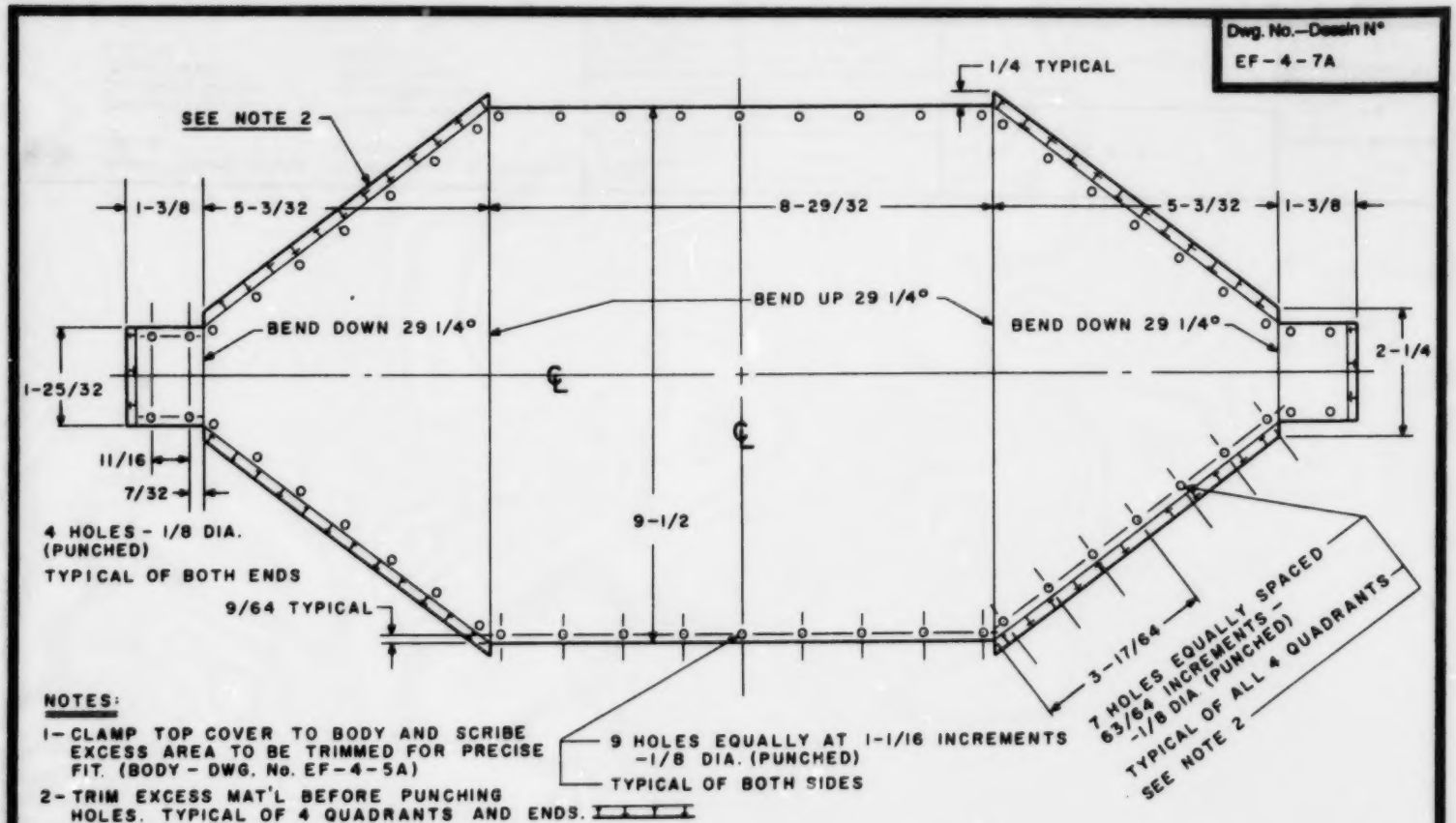
Dwg. No.–Dessin N°
EF – 4 – 6A


DRILL No. 43 (.089 DIA.) AND TAP 4-40 THRU
-4 HOLES TO BE LOCATED ON ASS'Y BY SPOT DRILLING
OFF OF TOP COVER (DWG. No. EF-4-7A)
1-7/32 (OUTSIDE)
1-1/8 (OUTSIDE)
1-3/32

NOTE: ALL JOINTS WELDED

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL–MATÉRIAUX ———	TITLE–TITRE COAXIAL ADAPTER BOX (DEVELOPED)	
		CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY–QUANTITÉ 2		DATE DEC./84
		APPROVED BY / APPROUVÉ PAR	ASS'Y–ASSEMBLAGE EF – 4 – 4D	PROJECT–PROJET EXTRA FAST IMPULSE	Dwg. No.–Dessin N° EF – 4 – 6A

SHEET / FEUILLE 2 OF / DE 2



NOTES:

1- CLAMP TOP COVER TO BODY AND SCRIBE EXCESS AREA TO BE TRIMMED FOR PRECISE FIT. (BODY - DWG. No. EF-4-5A)

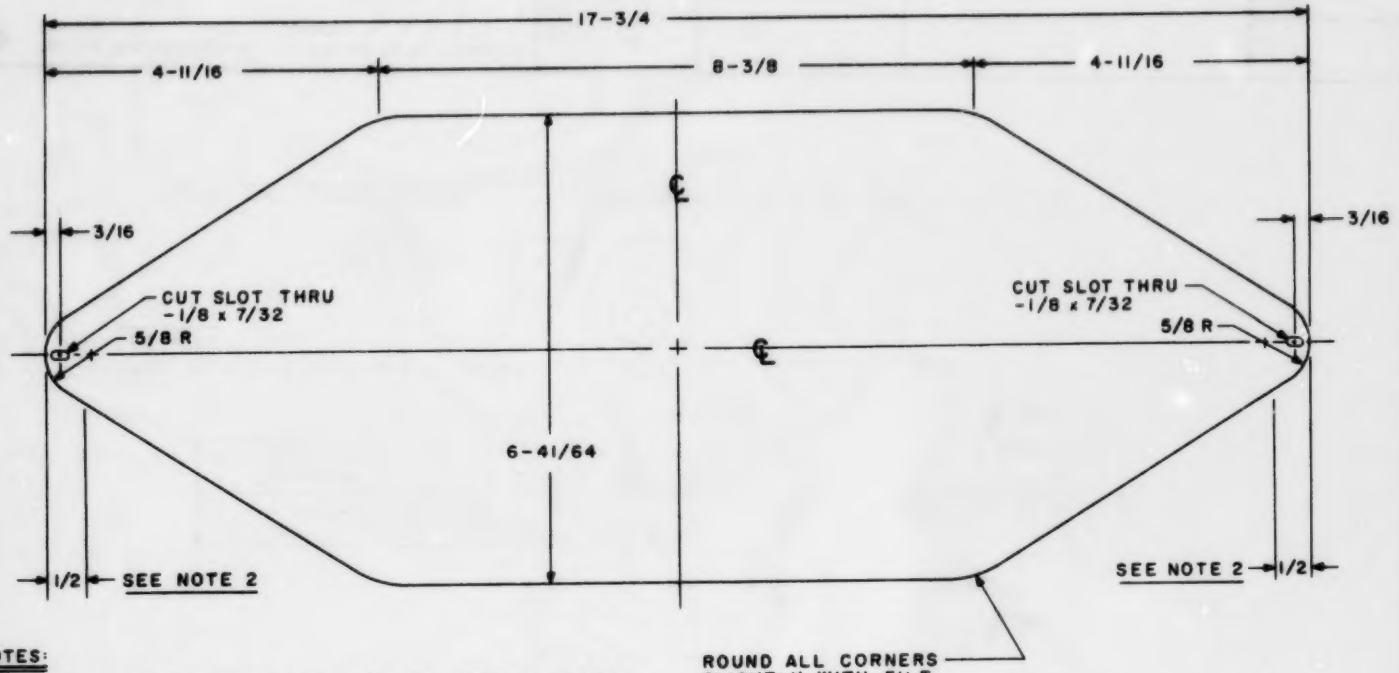
2- TRIM EXCESS MAT'L BEFORE PUNCHING HOLES. TYPICAL OF 4 QUADRANTS AND ENDS.

3- REMOVE ALL BURRS AND SHARPS EDGES.

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8 Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX 6061T6 ALUM. .125 THICK	TITLE—TITRE TOP COVER		
	CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY—QUANTITÉ 1	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC./84	
	APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D		Dwg. No.—Dessin N° EF-4-7A	

SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-8A



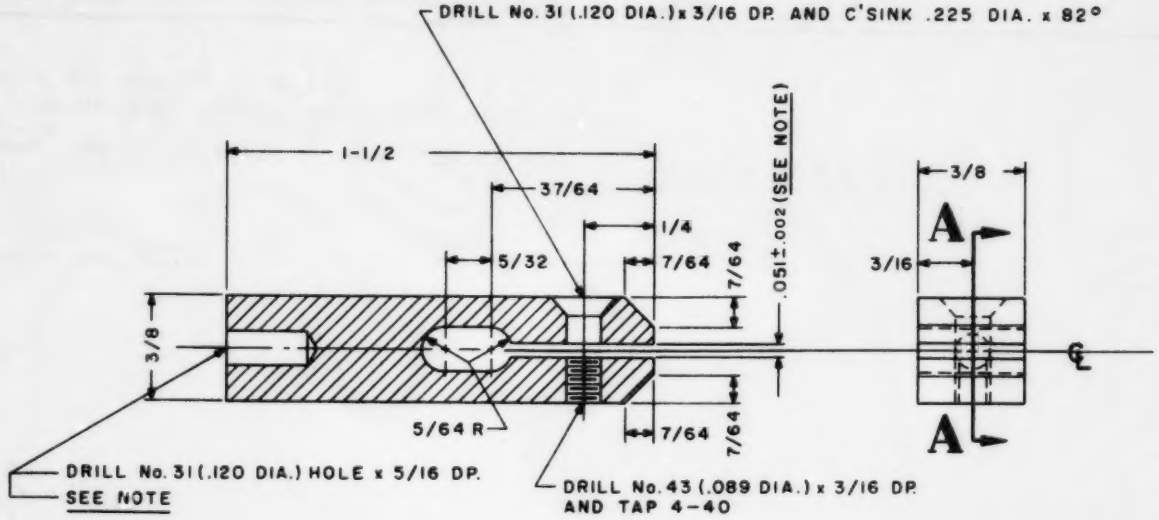
NOTES:

1— FINISHED QUALITY OF BRASS MUST BE SCRATCH FREE AND FLAT.
2— ROUGHEN INDICATED SURFACE WITH MEDIUM EMERY PAPER.
3— REMOVE ALL BURRS & SHARP EDGES.

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P.AMIRAULT	MATERIAL—MATÉRIAUX HARD BRASS .050 THICK	TITLE—TITRE SEPTUM	
		CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY—QUANTITÉ 1	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC. / 84
		APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D		Dwg. No.—Dessin N° EF-4-8A

SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-9A



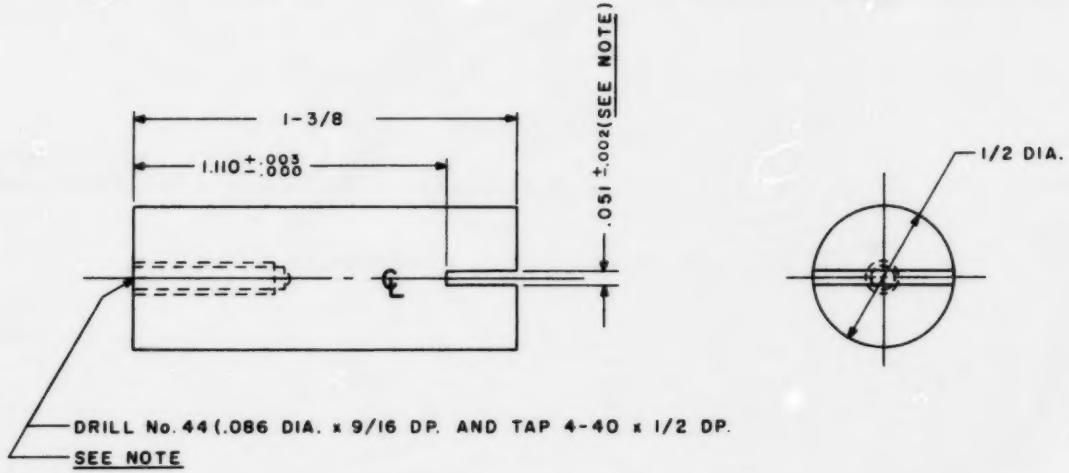
SECTION A-A

NOTE: THE CONCENTRICITY OF INDICATED HOLE AND SLOT TO BE WITHIN ±.001.

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR: P. AMIRAULT CHECKED BY / VÉRIFIÉ PAR: D. HOEY APPROVED BY / APPROUVÉ PAR:	MATERIAL—MATÉRIAUX: BRASS QUANTITY—QUANTITÉ: 2 ASS'Y—ASSEMBLAGE: EF-4-4D	TITLE—TITRE: CONNECTOR BAR PROJECT—PROJET: EXTRA FAST IMPULSE	DATE: DEC./84 Dwg. No.—Dessin N°: EF-4-9A

SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-10A

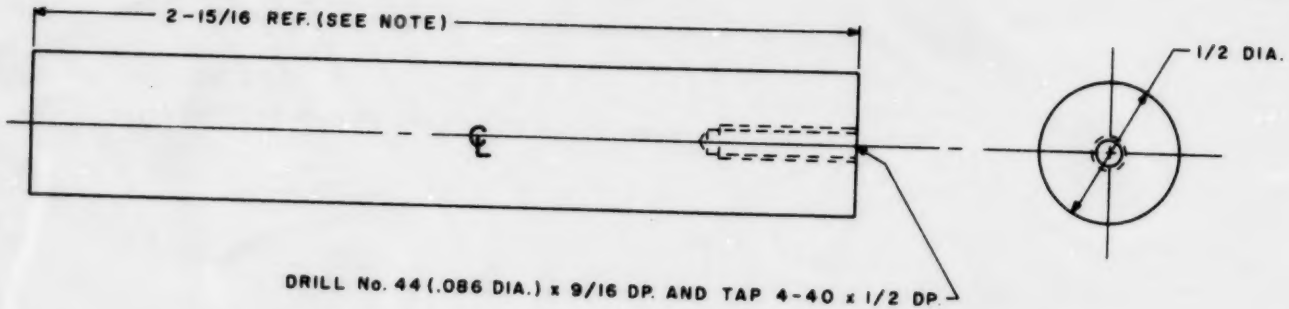


NOTE: THE CONCENTRICITY OF TAPPED HOLE AND SLOT TO BE WITHIN ±.002

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX TEFLON	TITLE—TITRE SPACER	
		CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY—QUANTITÉ 4	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC./84
		APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D		Dwg. No.—Dessin N° EF-4-10A

SHEET / FEUILLE — OF / DE

Dwg. No.—Dessin N°
EF-4-11A

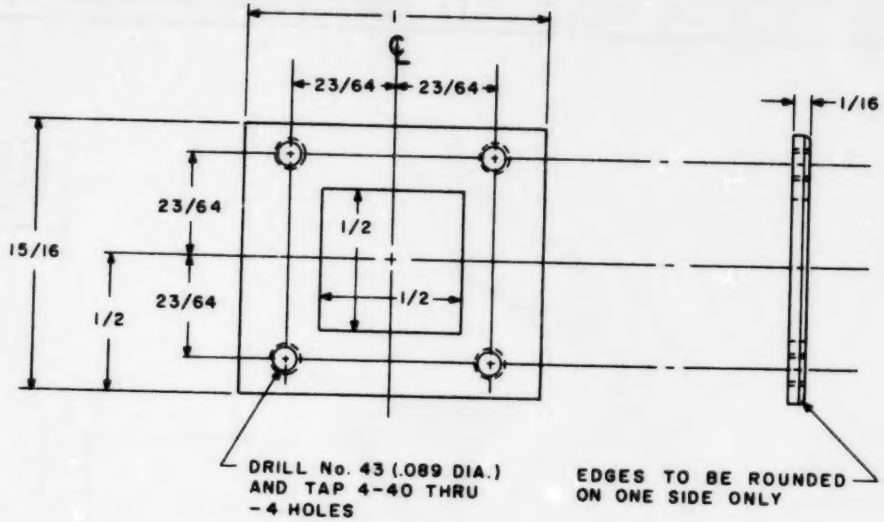


NOTE: SEE PROCEDURE FOR POSITIONING SEPTUM – STEP 4.
(DWG. No. EF-4-4D, SHEET 1 OF 4)

National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8	Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX TEFLON	TITLE—TITRE SEPTUM SUPPORTS	
		CHECKED BY / VÉRIFIÉ PAR D. HOEY	QUANTITY—QUANTITÉ 2	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC./84
		APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D		Dwg. No.—Dessin N° EF-4-11A

SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-12A



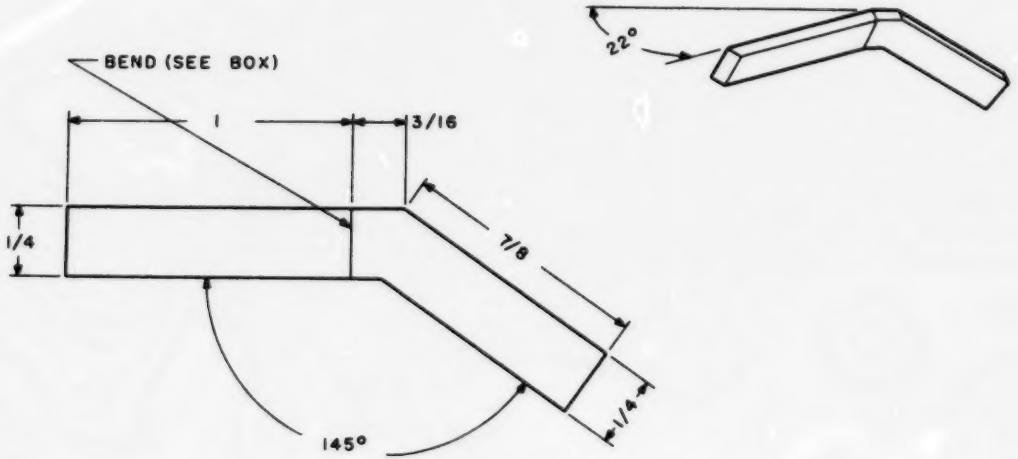
National Research Council Canada
Radio and Electrical Engineering Division
Ottawa, Canada
K1A 0R8

Conseil national de recherches Canada
Division de radiotechnique et de génie électrique
Ottawa, Canada
K1A 0R8

DRAWN BY / DESSINÉ PAR: P. AMIRAULT	MATERIAL—MATÉRIAUX: STAINLESS STEEL	TITLE—TITRE: COAXIAL CONNECTOR MOUNTING PLATE	
CHECKED BY / VÉRIFIÉ PAR: D. HOEY	QUANTITY—QUANTITÉ: 2		DATE: DEC./84
APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE: EF-4-4D	PROJECT—PROJET: EXTRA FAST IMPULSE	Dwg. No.—Dessin N°: EF-4-12A

SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-13A



TYPE	QT'Y	DESCRIPTION
A	2	BEND UP 22°
B	2	BEND DOWN 22°

National Research Council Canada
Radio and Electrical Engineering Division
Ottawa, Canada
K1A 0R6

Conseil national de recherches Canada
Division de radiotechnique et de génie électrique
Ottawa, Canada
K1A 0R8

DRAWN BY / DESSINÉ PAR: P. AMIRAULT
CHECKED BY / VÉRIFIÉ PAR: D. HOEY
APPROVED BY / APPROUVÉ PAR:

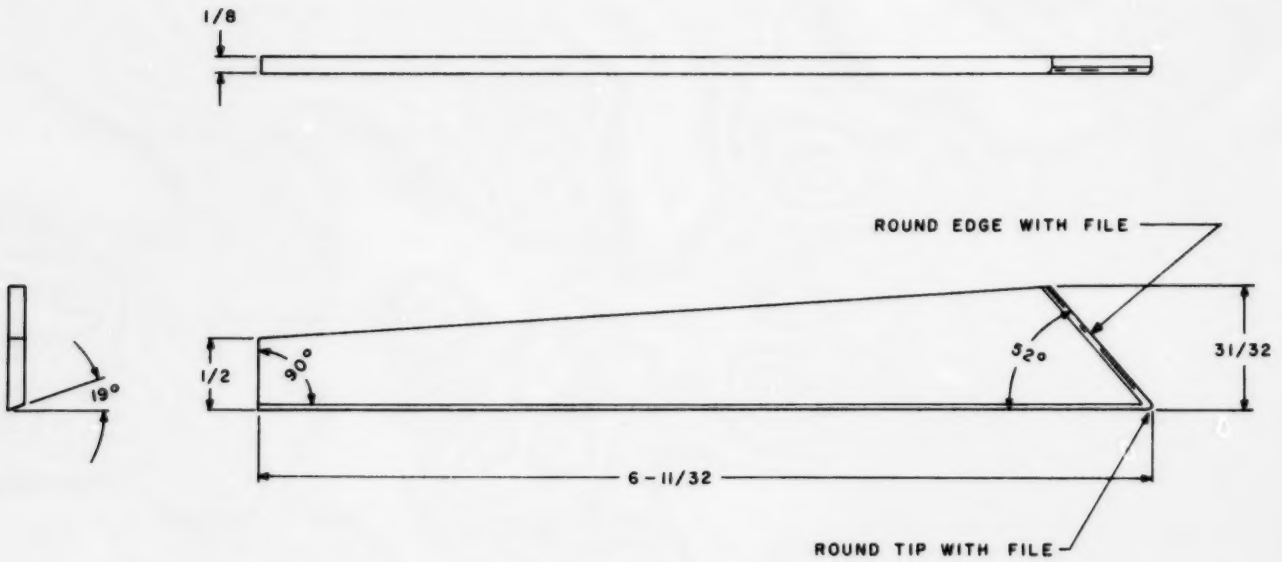
MATERIAL—MATÉRIAUX: HARD COPPER 1/16 THICK
QUANTITY—QUANTITÉ: SEE BOX
ASS'Y—ASSEMBLAGE: EF-4-4D SHEET 4 OF 4

TITLE—TITRE: DEVELOPMENT FIXTURE - A
PROJECT—PROJET: EXTRA FAST IMPULSE

DATE: DEC./84
Dwg. No.—Dessin N°: EF-4-13A

SHEET / FEUILLE
OF / DE

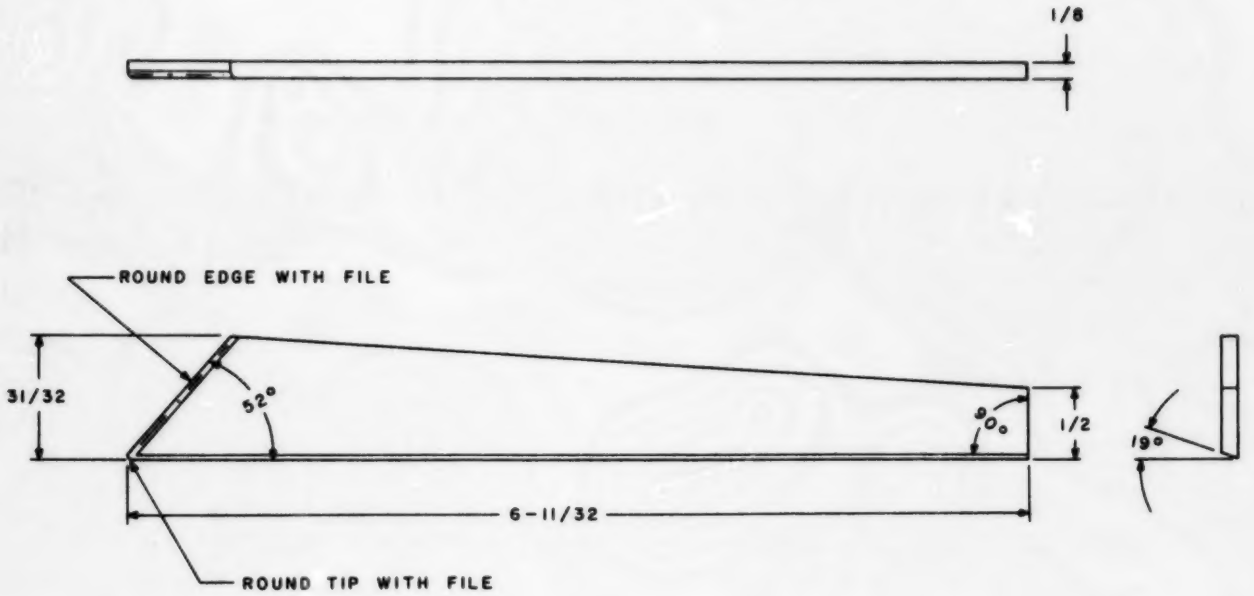
Dwg. No.—Dessin N°
EF-4-14A



National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R8 Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R8	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX HARD COPPER .125 THICK	TITLE—TITRE DEVELOPMENT FIXTURE - B		
	CHECKED BY / VÉRIFIÉ PAR	QUANTITY—QUANTITÉ 2	PROJECT—PROJET EXTRA FAST IMPULSE	DATE DEC. /84	
	APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D SHEET 4 OF 4		Dwg. No.—Dessin N° EF-4-14A	

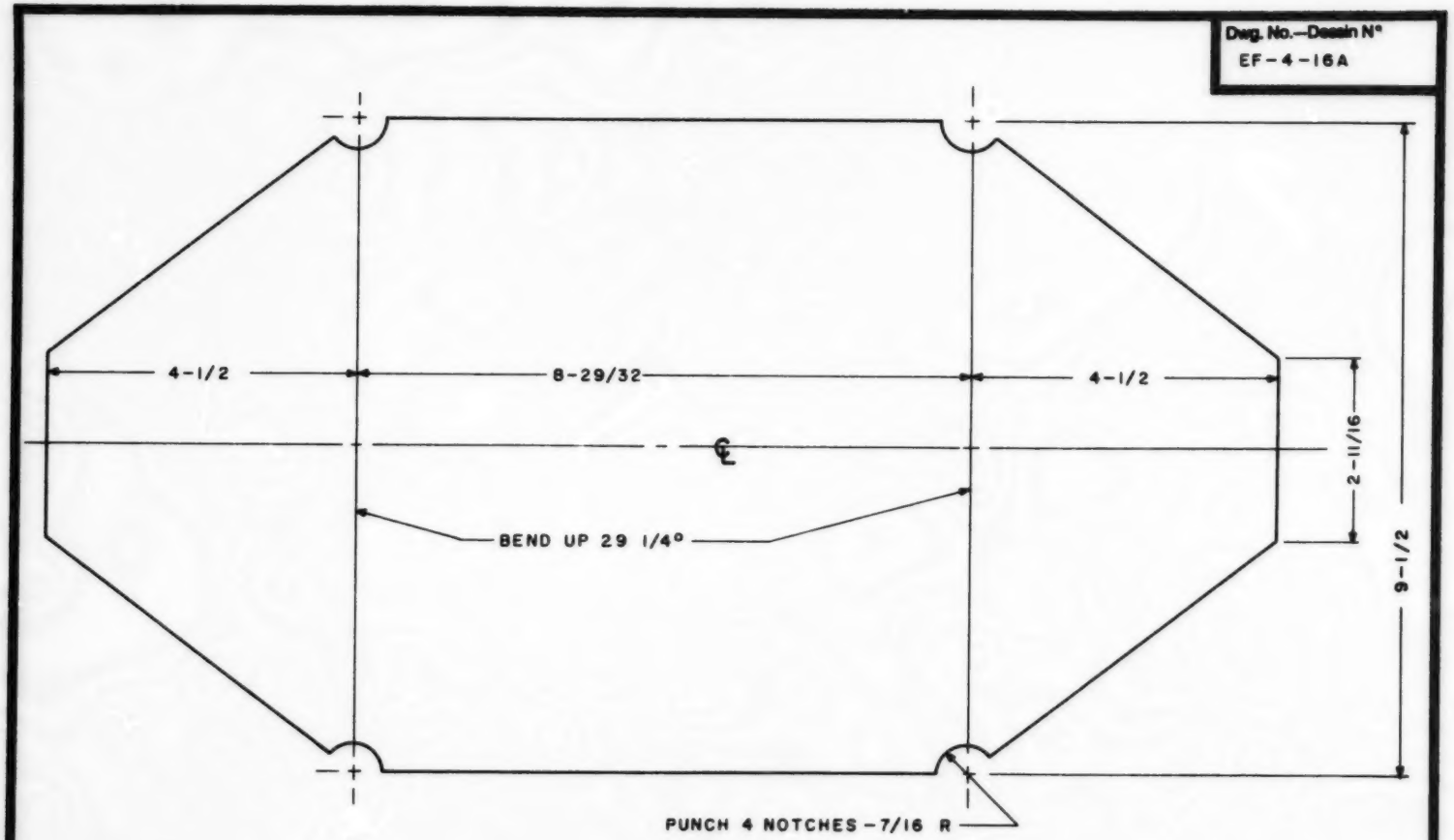
SHEET / FEUILLE OF / DE

Dwg. No.—Dessin N°
EF-4-15A



National Research Council Canada Radio and Electrical Engineering Division Ottawa, Canada K1A 0R6 Conseil national de recherches Canada Division de radiotechnique et de génie électrique Ottawa, Canada K1A 0R6	DRAWN BY / DESSINÉ PAR P. AMIRAULT	MATERIAL—MATÉRIAUX HARD COPPER .125 THICK	TITLE—TITRE DEVELOPMENT FIXTURE-C		
	CHECKED BY / VÉRIFIÉ PAR	QUANTITY—QUANTITÉ 2		DATE DEC./84	
	APPROVED BY / APPROUVÉ PAR	ASS'Y—ASSEMBLAGE EF-4-4D SHEET 4 OF 4	PROJECT—PROJET EXTRA FAST IMPULSE	Dwg. No.—Dessin N° EF-4-15A	

SHEET / FEUILLE OF / DE


Dwg. No.—Dessin N°
EF-4-16A
4-1/2
8-29/32
4-1/2
2-11/16
9-1/2
BEND UP 29 1/4°
PUNCH 4 NOTCHES – 7/16 R
National Research Council Canada
Radio and Electrical Engineering Division
Ottawa, Canada
K1A 0R8
Conseil national de recherches Canada
Division de radiotechnique et de génie électrique
Ottawa, Canada
K1A 0R8
DRAWN BY DESSINÉ PAR
P. AMIRAULT
CHECKED BY VÉRIFIÉ PAR
D. HOEY
APPROVED BY APPROUVÉ PAR
MATERIAL—MATÉRIAUX
MILD STEEL .078 THICK
QUANTITY—QUANTITÉ
1
ASS'Y—ASSEMBLAGE
EF-4-4D
SHEET 4 OF 4
TITLE—TITRE
DEVELOPMENT FIXTURE-D
PROJECT—PROJET
EXTRA FAST IMPULSE
DATE
DEC./84
Dwg. No.—Dessin N°
EF-4-16A
SHEET FEUILLE
OF DE